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A NOTE ON THE BLADDER KELP, NEREOCYSTIS LÜTKEANA

By W. A. Cannon

One of the most interesting forms of the West Coast marine algae is the bladder kelp (*Nereocystis Lütkeana* Post. & Rupr.). This is closely related to the giant kelp (*Macrocystis*), to the sea palm (*Postelsia*), to the devil's apron (*Laminaria*), and to other forms which are familiar to all frequenters of the coast of middle California.

In these algae there is an interesting correlation between the environment and the structure and certain other peculiarities of the plants. They not only vary in the length of the daily exposure to the air, but, in addition, they occupy a varying position with regard to the impact of the waves. The bladder kelp is normally never out of the water, while the sea palm is regularly exposed to the drying influence of the atmosphere, and the other kelps vary between these extremes. The different relation of these forms to the waves, which will be spoken of later in this sketch, is presumably the basal cause of a certain and unexpected weakness of the stem of *Nereocystis*, as well as accounting for the great mechanical strength of the stem of *Postelsia*. The examination of other kelps would undoubtedly disclose quite as remarkable a connection between the plants and their individual surroundings.

The bladder kelp is light brown in color and somewhat translucent. It is said to reach a length of 300 feet and is therefore to be reckoned as one of the largest marine plants. The blad-

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der kelp grows near shore attached to the sea bottom and reaches to the surface of the water, upon which the larger part of it floats. The plant may be divided into three main regions : a holdfast, a stem, and a crown. The holdfast is made up of root-like processes which attach themselves to the rock, or to a fragment of rock, and they form a body that may reach a diameter of two feet or so. The holdfast is so securely attached to its foundation that, if it is a boulder, the rock in a storm may be dragged by the kelp from its bed to a place high on the beach.

The stem of this kelp is for the most part hollow and of variable diameter. Where the stem leaves the holdfast, it is less than an inch in diameter, and it gradually increases the diameter until, at a place just below the free end, it may be three or more inches in transverse section. The stem ends in an enlargement, beneath which it is somewhat constricted, and to the oblong enlargement the name of bladder or cyst is given. The bladder is hollow and its cavity is continuous with that of the stem. The cyst may attain a length of eight inches, although commonly it is considerably less. The wall of the stem, where it is hollow, and of the cyst is about half an inch in thickness.

The crown is composed of two groups of leaves or sporophylls attached to the free end of the bladder. They are entire and leathery, and like the rest of the plant, are smooth. The leaves vary much in length but seldom exceed three feet, and in the plants examined they are on the average one inch wide, tapering somewhat toward the end. They bear, in certain areas called sori, masses of asexual reproductive bodies. It need hardly be said that all of the measurements vary with the age of the plant. Those which I have given may probably be regarded as the maximum in the species as I have seen it. Much larger figures are given by observers farther to the northward.

The relation of the bladder kelp to the impact of the waves is such that it is subjected to stresses almost exclusively of one kind, namely, to pulls in a direction parallel to the long axis. The pounding to which some kelps, as for instance the sea palm, are subjected by the waves seems to be entirely wanting in the present case. The endeavor of the plant to keep to the surface of

the water, the level of which is perpetually changing, and the pulling action of the ebb and flow of the tide cause the free end to tug at the holdfast like a ship at anchor.

A few summers ago I wished to put up material of the "fruit" of *Nereocystis* for microscopical examination and for the purpose it was necessary to obtain fresh sporophylls. I found a place near the Hopkins Seaside Laboratory where the plants grew in abundance. They were out of reach from the shore by hand but I found that they could be reached with a long-handled gaff-hook. The attempt was made at first to pull from the water the smallest by placing the hook back of the bladder, but I was unable to get any plants in this manner. Next the hook was used as a hatchet in the hope that some of the leaves might be torn away, but they were so tough and smooth that this also failed. Finally, I tried to tear the cyst in two by striking the sharp hooks into it; much to my surprise the large bladders cracked across like the most fragile substance. I tried repeatedly blows of varying force and found that even a slight one was sufficient to break either the cyst or the stem. Through this unexpected weakness of the plant I had no difficulty in obtaining all of the sporophylls that were desired. It should be said that the plant loses this brittle character when it is exposed to the air.

In seeking for a cause of this mechanical weakness of the stem of the bladder kelp, *i. e.*, to its inability to withstand the stresses to which I subjected it, it occurred to me to compare the habitat of another form, as for instance the sea palm, with that of the bladder kelp and also the mechanical strength of the former with that of the latter. The sea palm was chosen because its habitat and habit are well marked and quite different from that of the bladder kelp. These will be considered very briefly.

The sea palm is usually about two feet high. Like the bladder kelp, it has a holdfast, a stem, and a crown of leaves or sporophylls. The stem is upright and quite independent of support from the water. The plant grows on sloping rocks between tide marks. The position of the sea palm is such that it is pounded with inconceivable force by the waves in the times of high seas, and always when the tide is in, it is subject to the

direct impact of the waves. There are several sorts of forces thus brought to bear upon the sea palm. The waves may strike the plant at right angles to the long axis, they may tend to crush the plant to the surface of the rock by their great weight, or they may exert a pulling force. And the plant has become a sort of living resultant of these forces.

To compare the two kelps with regard to the mechanical strength, I applied to the sea palm the same sort of blow that had been previously given to the bladder kelp. The result was what one would expect; it did not have the slightest effect. In addition, I found it quite impossible to wrench the kelps from their station, however hard I might try.

Briefly, it would appear then that the differences of the sea palm and the bladder kelp in habitat, more especially the difference in their exposure to the waves, go far to explain the differences which the plants themselves exhibit as regards mechanical strength, and, further, these plants appear to be able to withstand those stresses best which also occur among the conditions of their environment.

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THE NORTH AMERICAN TWINFLOWERS

By P. A. Rydberg

In all our manuals of botany, *Linnaea* is given as a monotypic genus, consisting of only *L. borealis* L. One variety has, however, been recognized by some botanists, viz., *L. borealis* var. *longiflora* Torr., described from the collection made on the Wilkes Expedition. This is found in the extreme eastern portion of Asia as well as on the American Pacific Coast from Alaska to California, and extends also into the Rocky Mountain region in British Columbia and Idaho. In connection with my work on the flora of the Rockies, I happened some time ago to look up the record of this plant. As a rule, it is easily distinguished from the common twinflower of the East and of the Rockies by its much longer leaves, especially on the flowering branches. In depau-